POLYESTER DIFFERENT SHRINKAGE COMBINED FILAMENT YARN AND PROCESS FOR ITS PRODUCTION

FIELD OF THE INVENTION

The present invention relates to a polyester combined filament yarn comprising self-extending polyester multifilament yarn and heat-shrinkable polyester multifilament yarn. More specifically, the invention relates to polyester combined filament yarn which is particularly suitable for obtaining fabrics exhibiting a dry touch and high resiliency not found in the prior art.

BACKGROUND ART

Combined filament yarn, comprising self-extending polyester multifilament yarn which extends with heat treatment and heat-shrinkable polyester multifilament yarn which shrinks with heat treatment, becomes bulky with a soft and flexible feel when subjected to heat treatment, and it is therefore widely used for textile purposes.

Production of conventional polyester combined filament yarn of this type is accomplished by using an air jet nozzle to combine separately produced self-extending polyester multifilament yarn and heat-shrinkable polyester multifilament yarn, or by conducting relaxation heat treatment of polyester multifilament yarn which becomes self-extending by relaxation heat treatment, while supplying heat-shrinkable polyester multifilament yarn continuously to the self-extending polyester multifilament yarn after the relaxation heat treatment, for combination with an air jet nozzle (for example, Japanese Unexamined Patent Publication No. 1-250425).

When such polyester combined filament yarn is used, for example, in a worsted fabric having a highly repulsive wool-like touch, a non-contact heater such as a slit heater or pipe

heater is used for high-temperature second relaxation heat treatment of the self-extending polyester multifilament yarn after the relaxation heat treatment, and this is then combined with the heat-shrinkable polyester multifilament yarn. Since the self-extending polyester multifilament yarn sways inside the non-contact heater during the second relaxation heat treatment and can therefore easily contact with the heater, the leveling property is impaired and yarn breakage tends to easily occur. A method for solving this problem has been proposed in Japanese Patent Publication No. 3054059, for example, wherein the polyester multifilament yarn which becomes self-extending by relaxation heat treatment is pre-interlaced with the heat-shrinkable polyester multifilament yarn, prior to the relaxation heat treatment.

However, while the polyester combined filament yarn obtained by this method produces a soft and flexible feel, it does not yield fabrics with an excellent dry touch and both softness and resiliency.

SUMMARY OF THE INVENTION

It is an object of the present invention to solve the aforementioned problems of the prior art by providing a polyester combined filament yarn comprising self-extending polyester multifilament yarn and heat-shrinkable polyester multifilament yarn, which is particularly suitable for obtaining fabrics exhibiting a dry touch and high resiliency not found in the prior art.

As a result of much diligent research directed toward achieving the object stated above, the present inventors completed the present invention after finding that if a polyester multifilament yarn comprising a core portion and a plurality of fin portions protruding in a radial fashion from the core portion along the lengthwise direction of the core portion is used as the polyester multifilament yarn which becomes self-extending with heating, it is possible to obtain

a polyester combined filament yarn which is suitable for obtaining fabrics exhibiting a dry touch and high resiliency not found in the prior art, and that if relaxation heat treatment is carried out after interlacing of the polyester multifilament yarn which becomes self-extending and the heat-shrinkable polyester multifilament yarn, the quality of the resulting combined filament yarn is satisfactory.

In other words, the present invention provides a polyester combined filament yarn composed of a self-extending polyester multifilament yarn A and a heat-shrinkable polyester multifilament yarn B, the polyester combined filament yarn being characterized in that the polyester multifilament yarn A comprises a core portion and a plurality of fin portions protruding in a radial fashion from the core portion along the lengthwise direction of the core portion, and in that the following conditions (a) to (c) are simultaneously satisfied.

(a) $1/20 \leq S_B/S_A \leq 1/3$

(b) $0.6 \leq L_B/D_A \leq 3.0$

(c) $W_B/D_A \leq 1/4$

(where S_A represents the cross-sectional area of the core portion, D_A represents the diameter of the core portion when the cross-section is a circle and the circumscribed circle diameter when it is not a circle, and S_B, L_B and W_B represent the cross-sectional area, maximum length and maximum width, respectively, of the fin portions.)

According to the invention, there is further provided a process for production of the aforementioned polyester combined filament yarn characterized in that heat-shrinkable polyester multifilament yarn B' is paralleled with multifilament yarn A' which becomes the self-extending polyester multifilament yarn A when subjected to relaxation heat treatment, and after supplying them to an interlacing nozzle with an overfeed for interlacing, heat relaxation treatment is carried out to impart a self-extending property

to the polyester multifilament yarn A', prior to a second relaxation heat treatment with a non-contact heater.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a cross-sectional view showing an example of a lateral cross-section of polyester multifilament yarn A according to the invention.

Fig. 2 is a schematic view showing an example of a process for production of polyester combined filament yarn according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

The polyester used for the invention is a polyester having ethylene terephthalate as the main repeating unit, and for improved dyeing, piling resistance and heat shrinkage properties, it may also include copolymerization of a small amount (normally no greater than 15 mole percent and preferably no greater than 10 mole percent) of a third component. Another polymer may further be combined therewith in a small amount (normally no greater than 10 wt% with respect to the polyester). In addition, there may be included additives such as electrostatic agents, delustering agents, ultraviolet absorbers, dyeing improvers and the like.

The polyester combined filament yarn of the invention is composed of a self-extending polyester multifilament yarn A and a heat-shrinkable polyester multifilament yarn B, and the self-extending polyester multifilament yarn A and heat-shrinkable polyester multifilament yarn B may be made of the same polyester or of polyesters with different types and amounts of copolymerizing components, combined polymers, additives or the like. Preferred is a combined filament yarn wherein the self-extending polyester multifilament yarn is made of polyethylene terephthalate and the heat-shrinkable polyester multifilament yarn is made of polyethylene terephthalate copolymerized with about 5-15 mole percent of,

for example, an isophthalic acid component as a third component (based on the total acid component).

The self-extending polyester multifilament yarn A used for the invention may be obtained by relaxation heat treatment of unstretched polyester filament spun at a relatively high spinning speed of about 2000-5000 m/min (usually referred to as partially oriented yarn, POY), or of low-oriented unstretched polyester yarn or partially oriented yarn stretched to a low factor, and spun at a spinning speed of about 1000 m/min. For example, there may be mentioned a method of stretching low-oriented unstretched polyester yarn at a low factor and then subjecting it to shrinkage treatment of 20% or greater at a temperature of 90°C or below, a method of stretching partially oriented yarn with a birefringence of 0.02-0.08 at a temperature of no greater than (glass transition temperature + 20°C), and then subjecting it to relaxation heat treatment, a method of low temperature stretching of polyester partially oriented yarn (POY) with a birefringence (Δn) of 0.03 or greater which has been spun at a spinning speed of 1500-4500 m/min and then subjecting it to relaxation heat treatment, or a method of stretching partially oriented yarn in a range from the secondary transition temperature (Tg) to Tg + 20°C and then subjecting it to relaxation heat treatment to a shrinkage rate of 20% or greater.

Thus, the polyester multifilament yarn A' used for production of the polyester combined filament yarn of the invention is polyester multifilament yarn in a state prior to relaxation heat treatment to impart the self-extending property, and specifically, it is partially oriented yarn (POY) or yarn stretched to a low factor.

According to the invention, the self-extending polyester multifilament yarn A described above is polyester multifilament yarn comprising a core portion and a plurality of fin portions protruding in a radial fashion from the core

portion along the lengthwise direction of the core portion, and it is important for it to simultaneously satisfy the following conditions (a) to (c):

(a) $1/20 \leq S_B/S_A \leq 1/3$

(b) $0.6 \leq L_B/D_A \leq 3.0$

(c) $W_B/D_A \leq 1/4$

where S_A and D_A represent, respectively, the cross-sectional area and diameter (the circumscribed circle diameter when the core portion is not a circle) of the core portion, and S_B, L_B and W_B represent, respectively, the cross-sectional area, maximum length and maximum width of each fin portion, as shown in Fig. 1.

If $1/20 > S_B/S_A$ or $1/3 < S_B/S_A$, i.e. if fin portions are present having a cross-sectional area which is smaller than 1/20 or larger than 1/3 of the cross-sectional area of the core portion, the dry touch feel of the obtained combined filament yarn will be inadequate.

If $0.6 > L_B/D_A$, i.e. if fin portions are present having a maximum length less than 0.6 times the diameter of the core portion, the dry touch feel of the obtained combined filament yarn will be inadequate, while if $3.0 < L_B/D_A$, i.e. if fin portions are present having a maximum length greater than 3.0 times the diameter of the core portion, the fin portions will tend to fold so that only a coarse feel will be obtained, and the leveling property will be impaired.

If $W_B/D_A > 1/4$, i.e. if fin portions are present having a maximum width greater than 1/4 of the diameter of the core portion, the resulting combined filament yarn will not exhibit a soft feel.

A smaller maximum width of the fin portions will result in a softer feel, but if it is too small, problems may be encountered such as bending of the fin portions or impairment of the leveling property, and therefore the minimum value of W_B/D_A is preferably about 1/8.

On the other hand, the heat-shrinkable polyester multifilament yarn B is preferably polyester multifilament stretched yarn having a boiling water shrinkage of 8.0% or greater, and more preferably, it is polyester multifilament stretched yarn having a boiling water shrinkage of 10-16%. An example of such heat-shrinkable polyester multifilament yarn is non-heat-set polyester multifilament stretched yarn, and multifilament stretched yarn comprising a polyester copolymerized with about 5-15 mole percent of a third component such as isophthalic acid.

In the polyester combined filament yarn of the invention, the self-extending polyester multifilament yarn A is situated relatively on the outer side of the combined filament yarn while the heat-shrinkable polyester multifilament yarn B is situated relatively on the inner side of the combined filament yarn, and therefore in order to achieve an enhanced feel of the combined filament yarn, the single fiber size of the polyester multifilament yarn A is 2-9 dtex and the single fiber size of the heat-shrinkable polyester multifilament yarn B is 3-11 dtex, with the former being preferably smaller than the latter. From the standpoint of deep-dyeing and swelling, the combining ratio of the self-extending polyester multifilament yarn A and heat-shrinkable polyester multifilament yarn B is preferably in a range of 8:2 to 5:5 as the weight ratio of A:B.

The combined filament yarn of the invention described above may be stably produced with low yarn breakage and satisfactory quality by the following method, for example. Specifically, the apparatus shown in Fig. 2 may be used for paralleling of the polyester multifilament yarn A' which exhibits a self-extending property upon relaxation heat treatment and the heat-shrinkable polyester multifilament yarn B', where they are interlaced at an overfeed using an interlacing nozzle 3 provided between a supply roll 1 and a first take-up roll (heated roll) 2.

In Fig. 2, since the first take-up roll 2 is heated and the polyester multifilament yarns A',B' are at an overfeed between the supply roll 1 and the first take-up roll 2, the polyester multifilament yarn A' wound around the first take-up roll 2 undergoes relaxation heat treatment on the roll, thus being imparted with a self-extending property. Next, a non-contact heater 5 provided between the first take-up roll 2 and a second take-up roll 4 is used for heat setting by second relaxation heat treatment, prior to winding onto a package 6.

The preferred number of interlaces is 50-90/m during interlacing of the polyester multifilament yarn A' and heat-shrinkable polyester multifilament yarn B', and therefore the overfeed rate will be suitably 1.0-1.5% in most cases.

As in the instance described above, it is preferred for the first take-up roll 2 to be heated for the self-extending property-imparting relaxation heat treatment, in order to render the apparatus more compact; however, when the overfeed rate (relaxation factor) required to impart the self-extending property by relaxation heat treatment is greater than the overfeed rate appropriate for interlacing with the interlacing nozzle 3, another take-up roll may be provided downstream from the first take-up roll 2 for a prescribed relaxation heat treatment between the take-up rolls. When the first take-up roll 2 is a heating roll, the heat treatment may be carried out with a prescribed overfeed rate (relaxation factor) on the roll, by making the diameter at the filament output end smaller than the diameter at the filament input end of the roll 2.

The temperature and overfeed rate (relaxation factor) during the relaxation heat treatment for imparting the self-extending property to the polyester multifilament yarn A' will differ depending on the type of yarn used as the polyester multifilament yarn A', but when partially oriented yarn (POY) spun at a spinning speed of, for example, 2000-3500 m/min and preferably 2500-3500 m/min, is used for relaxation heat

treatment on the first take-up roll (heated roll) 2, the roll surface temperature is preferably 100-130°C and the overfeed rate (relaxation factor) is preferably 1.0-1.5%.

The second relaxation heat treatment with the non-contact heater 5 is heat setting treatment in order to impart properties to the polyester combined filament yarn which are suitable for worsted fabrics with a high-resiliency wool-like touch, and it is preferably treatment at 210-240°C at an overfeed rate of 1.5-2.5%, while the treatment time will normally be 0.01-0.30 seconds. The boiling water shrinkage of the obtained polyester combined filament yarn will normally be about 5-13%. The non-contact heater 5 used may be a slit heater, pipe heater or the like.

In the method described above, the interlacing of the polyester multifilament yarn A' which exhibits a self-extending property upon relaxation heat treatment and the heat-shrinkable polyester multifilament yarn B' must be followed by relaxation heat treatment to impart the self-extending property to the multifilament yarn A', and this eliminates the possibility of contact of the filaments with the non-contact heater 5 during second relaxation heat treatment, so that a polyester combined filament yarn with a satisfactory leveling property can be stably produced while generating low yarn breakage. It is not preferred to use a method in which the polyester multifilament yarn A' is subjected to relaxation heat treatment by itself to produce a self-extending polyester multifilament yarn which is then heat set by a second relaxation heat treatment, followed by interlacing with heat-shrinkable polyester multifilament yarn B to produce polyester combined filament yarn, since the filaments can contact with the non-contact heater during the second relaxation heat treatment with the non-contact heater, resulting in dyeing spots and more yarn breakage.

EXAMPLES

Examples will now be provided for a more detailed explanation of the construction and effect of the invention.

Example 1

Polyethylene terephthalate with an intrinsic viscosity of 0.62 was melted by an ordinary method and spun at a spinning speed of 3000 m/min to obtain 84 dtex/24 filament (single fiber size: 3.3 dtex) polyester partially oriented yarn (POY) (polyester multifilament yarn A'). The S_B/S_A, L_B/D_A and W_B/D_A of the polyester multifilament were as shown in Table 1.

Separately, a polyethylene terephthalate-isophthalate copolymer polyester with an intrinsic viscosity of 0.64 (10.0 mole percent copolymerization of isophthalic acid) was melted at 280°C and spun at a spinning speed of 1450 m/min to obtain an unstretched yarn, which was then stretched to a factor of 2.9 at 87°C to obtain a 56 dtex/12 filament (single fiber size: 4.7 dtex) heat-shrinkable polyester yarn with a boiling water shrinkage of 15% (heat-shrinkable polyester multifilament yarn B').

The polyester multifilament yarn A' and heat-shrinkable polyester multifilament yarn B' were used to produce polyester combined filament yarn with the apparatus shown in Fig. 2. Specifically, both polyester multifilament yarns A' and B' were paralleled and supplied to an interlacing nozzle 3 situated between a supply roll 1 and a first take-up roll (heated roll with a surface temperature of 120°C) 2, at a speed of 600 m/min with a 1.2% overfeed rate, for interlacing by a pressure of 196 kPa (2.0 kg/cm^2) to produce an interlace of 65/m.

Next, the yarn was wound 8 times around the heated roll 2 at a surface temperature of 120°C while maintaining the 1.2% overfeed rate, and subjected to relaxation heat treatment to impart a self-extending property to the polyester multifilament yarn A'. A slit heater 5 provided between the heated roll 2 and a second take-up roll 4 was then used for

second relaxation heat treatment at 230°C with an overfeed of 2.0% for a period of 0.05 second to accomplish heat setting, and after winding twice onto a second take-up roll (cold roll) 4, it was wound up onto a package 6. During production of the polyester combined filament yarn, no contact of the yarn with the slit heater 5 was observed, and the yarn breakage was only once per spindle per day. The obtained combined filament yarn was woven into a plain weave with 60 strands/cm warp and 35 strands/cm weft, and then dyed black by ordinary dyeing at 135°C for 60 minutes. The obtained dyed fabric exhibited a bulky feel with a dry touch and high resiliency not found in the prior art.

The feel of the fabric was organoleptically evaluated based on the dry touch, soft feel and high resiliency property on an overall 4-level scale from A (very good) to D (poor).

Examples 2 and 3

Polyester combined filament yarn was obtained in the same manner as Example 1, except that the polyester multifilament yarn A' used in Example 1 was changed to each of the ones shown in Table 1. The fabric feel, leveling property and extending property were all satisfactory, as shown in Table 1.

Example 4

In Example 1, the polyester multifilament yarn A' was subjected to relaxation heat treatment alone on a heated roll with a 120°C surface temperature at a 1.2% overfeed rate to impart a self-extending property, and then a 230°C slit heater was used for second relaxation heat treatment for 0.05 second at a 2.0% overfeed rate, for heat setting. Next, the obtained self-extending polyester multifilament yarn A was paralleled with the heat-shrinkable polyester multifilament yarn B' and an interlacing nozzle was used for interlacing treatment under the same conditions as Example 1. During the second relaxation heat treatment of the polyester multifilament yarn

A' in this case, the yarn often swayed and contacted the slit heater, while the number of yarn breaks reached 20 per day per spindle. When the obtained combined filament yarn was woven and dyed in the same manner as Example 1, the fabric had a satisfactory feel but exhibited dyeing spots.

Comparative Example 1

A polyester combined filament yarn was obtained in the same manner as Example 1, except that the polyester multifilament yarn A' used in Example 1 was one with a round cross-section. The leveling property and extending property were satisfactory, but the fabric had absolutely no dry feel, and therefore the desired fabric feel was not obtained.

Table 1

	Number of fins	S_B/S_A	L_B/D_A	W_B/D_A	Fabric feel	Leveling property	Extending property
Example 1	4	1/4	1.0	1/5	A	good	satisfactory
Example 2	4	1/3	1.5	1/4	A	good	satisfactory
Example 3	6	1/4	0.8	1/5	B	good	satisfactory
Example 4	4	1/4	1.0	1/5	A	poor	unsatisfactory
Comparative Example 1	0	-	-	-	D	good	satisfactory

The polyester combined filament yarn of the invention is suitable for obtaining fabrics exhibiting a dry touch and high resiliency not found in the prior art, while being resistant to yarn breakage and having an excellent leveling property, and may therefore be utilized for a wide variety of fabric purposes.